

**Basic Recreational Use Attainability Analysis of  
Armand Bayou Above Tidal  
Segment 1113A**

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- List of local contacts
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- Completed field datasheets from all field surveys.

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- Photographic Record
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## **INTRODUCTION**

Armand Bayou is a coastal stream located in the San Jacinto-Brazos Coastal Basin. It originates south of the city of Houston and flows southeast. A tributary of Clear Lake, the lower 8 miles of Armand Bayou (segment 1113) are tidally influenced and rich in plant and animal life. However, the portion of Armand Bayou located above tidal influence (segment 1113A) is characterized by extensive residential development and general urbanization. The Texas Commission on Environmental Quality (TCEQ) evaluated water quality samples collected since 1998 and found that bacteria levels in Armand Bayou above tidal (segment 1113A) were occasionally elevated, indicating a potential risk to people who swim or wade in this portion of the bayou (Texas Commission on Environmental Quality [TCEQ] 2009a). In response to these conditions, the TCEQ initiated a project to determine the recreational use-attainability (RUAA) in Armand Bayou above tidal segment and to identify and characterize potential sources of bacteria pollution in the watershed.

## **BASIC RUAA BACKGROUND**

Recreational use attainability analyses (RUAs) are used to identify and assign attainable uses and criteria to individual water bodies. Applicable uses and associated criteria are defined in the Texas Surface Water Quality Standards (TSWQS). Texas currently has two recreation use categories in the 2000 TSWQS: contact and noncontact recreation. Contact recreation consists of recreational activities involving a significant risk of ingestion of water including: wading by children, swimming, water skiing, diving, and surfing. Noncontact recreation is considered aquatic recreational pursuits not involving a significant risk of water ingestion: including fishing, commercial and recreational boating, and limited body contact incidental to shoreline activity.

A Basic RUAA Survey is conducted to (1) collect information on a water body such as the presence or absence of water recreation activities, stream flow, and stream depth, (2) establish/verify a presumed use, or (3) provide core information to be included in a Comprehensive RUAA should one be deemed necessary. Basic RUAs can often be accomplished on a single sampling date. If at any point during the Basic RUAA Survey it becomes apparent that primary contact recreation is clearly the appropriate use for the water body the investigator can stop conducting the RUAA.

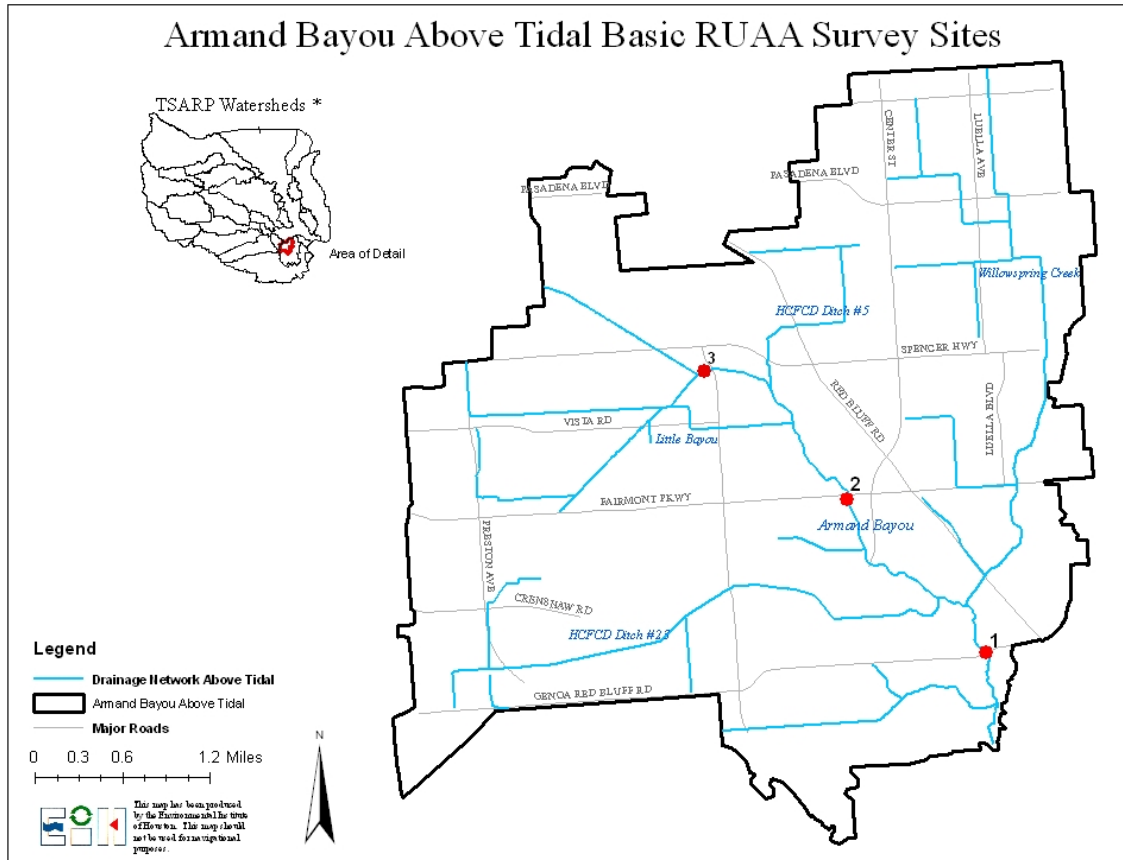
A Basic RUAA Survey should be conducted during a normal warm season and a period when people would be most likely to use the water body for contact recreational purposes. Basic RUAA Surveys should also be conducted during optimal sampling conditions that are representative of the normal flow conditions of the stream and are not storm-influenced. Basic RUAA field surveys for Armand Bayou above tidal (Segment 1113A) were conducted during Memorial Day (May 25<sup>th</sup>, 2009), Independence Day (July 4<sup>th</sup>, 2009), and Saturday, July 25<sup>th</sup>, 2009.

### **BASIC RUAA SURVEY SITE SELECTION**

In general, the target density of survey sites should be approximately three (3) sites per every five (5) miles of stream (Texas Commission on Environmental Quality (TCEQ) 2009b). During our study survey sites were established in areas where the water body is accessible to the public and has the highest potential for recreational use (road crossings, public lands/parks located near the water body, and populated areas). A total of three (3) survey sites were established (Table 1 & Figure 1-4).

**Table 1.** Sites used during the Basic RUAA Survey on Armand Bayou Above Tidal (corresponding to Figure 1).

Survey Site #	Site Description	Lat	Long
1	Armand Bayou and Genoa Red Bluff Rd	29.6339	-95.1142
2	Armand Bayou and Fairmont Pkwy	29.6502	-95.1289
3	Armand Bayou and Space Center Blvd	29.6630	-95.1450



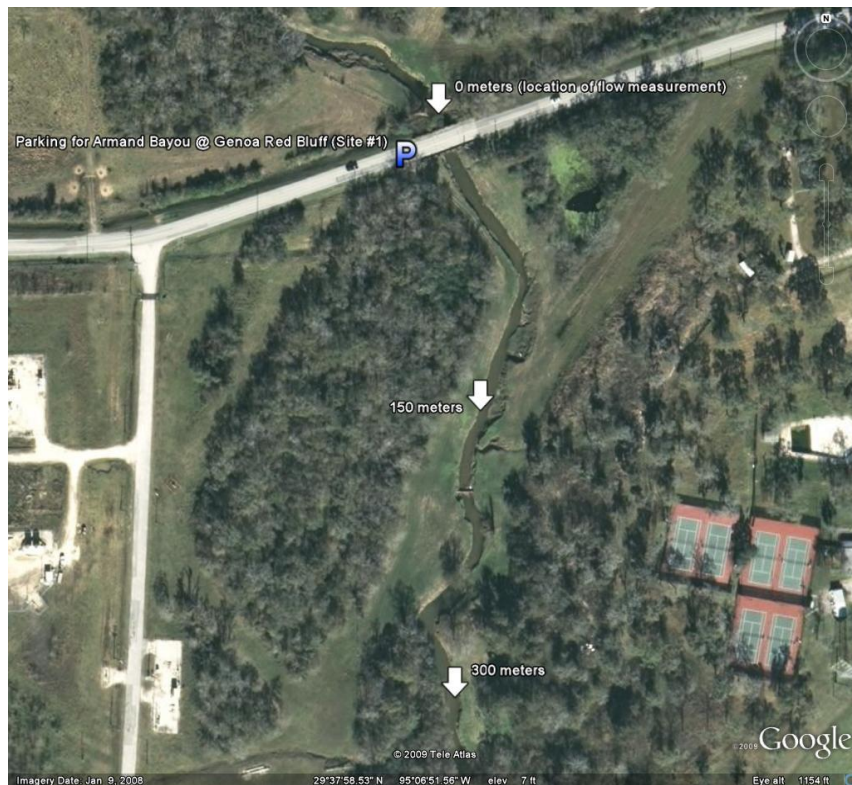
\*Tropical Storm Allison Recovery Project (TSARP) watershed delineation determined by Harris County Flood Control District (HCFCDD)

**Figure 1.** Basic RUAA survey sites selected based on river mile, accessibility, and recreational features. Aerial photos of the sites are included in the photographic record (Appendix 3).

Site selection for this Basic RUAA was facilitated by a previous investigation of Armand bayou Above Tidal, conducted as part of a Total Maximum Daily Load study initiated in February of 2008. The report titled “Pollutant Source Identification Report for Fecal Bacteria in

Armand Bayou, Non-tidal Segment (segment 1113A),” contains useful supplementary information such as watershed characteristics, hydrologic characteristics, the location of important features such as parks and natural areas, and the results of a search for TPDES wastewater treatment facilities discharging to Armand Bayou Above Tidal.

Prior to selecting these sites we also solicited input from regional experts familiar with the watershed via email and telephone. A contact information form was completed which documented contact with appropriate regional authorities in the watershed (Appendix 1).



**Figure 2.** Aerial view of Site # 1 (Genoa-Red Bluff @ Armand Bayou)



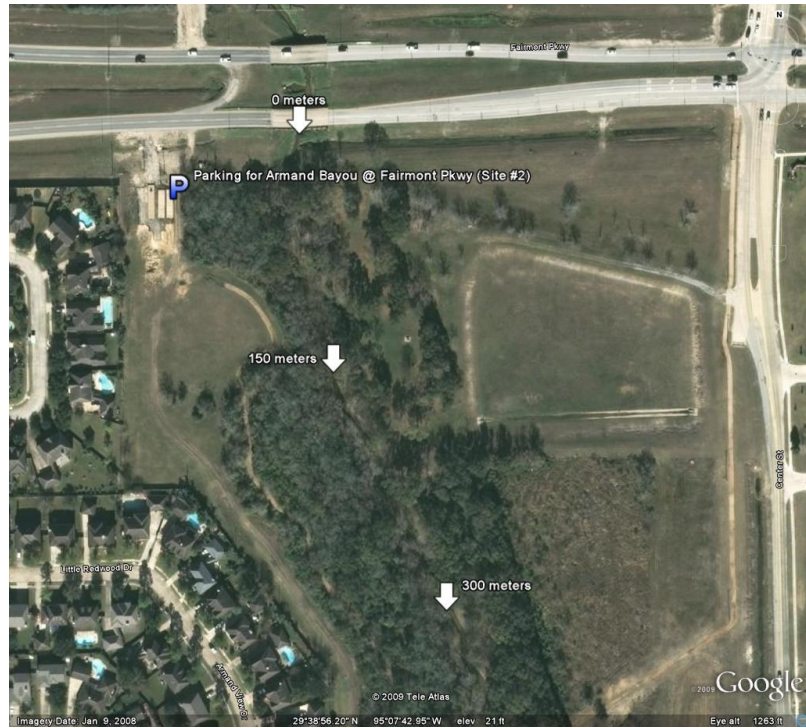


Figure 3. Aerial view of site 2 (Fairmont Parkway @ Armand Bayou).

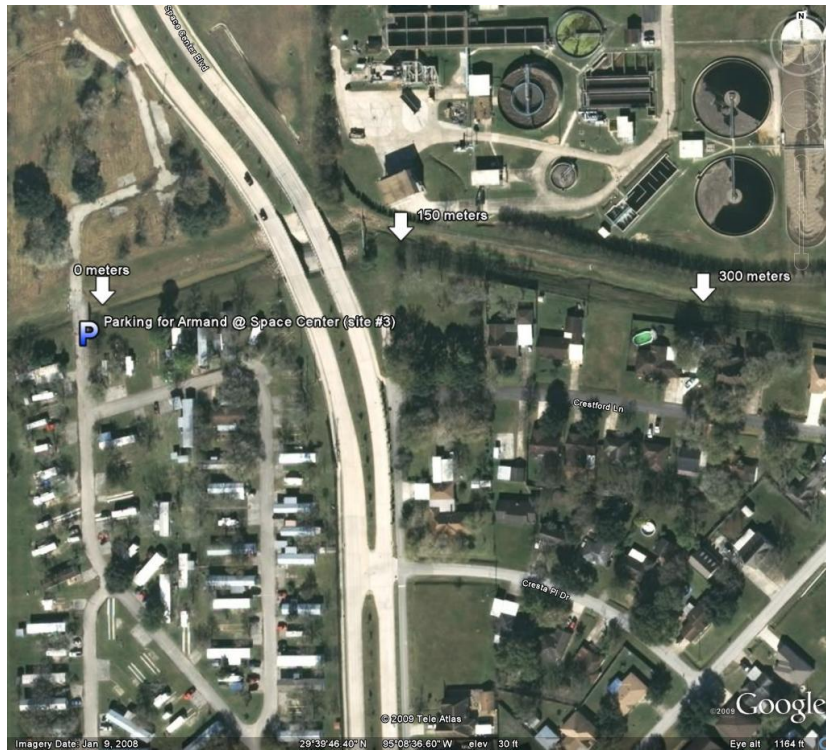


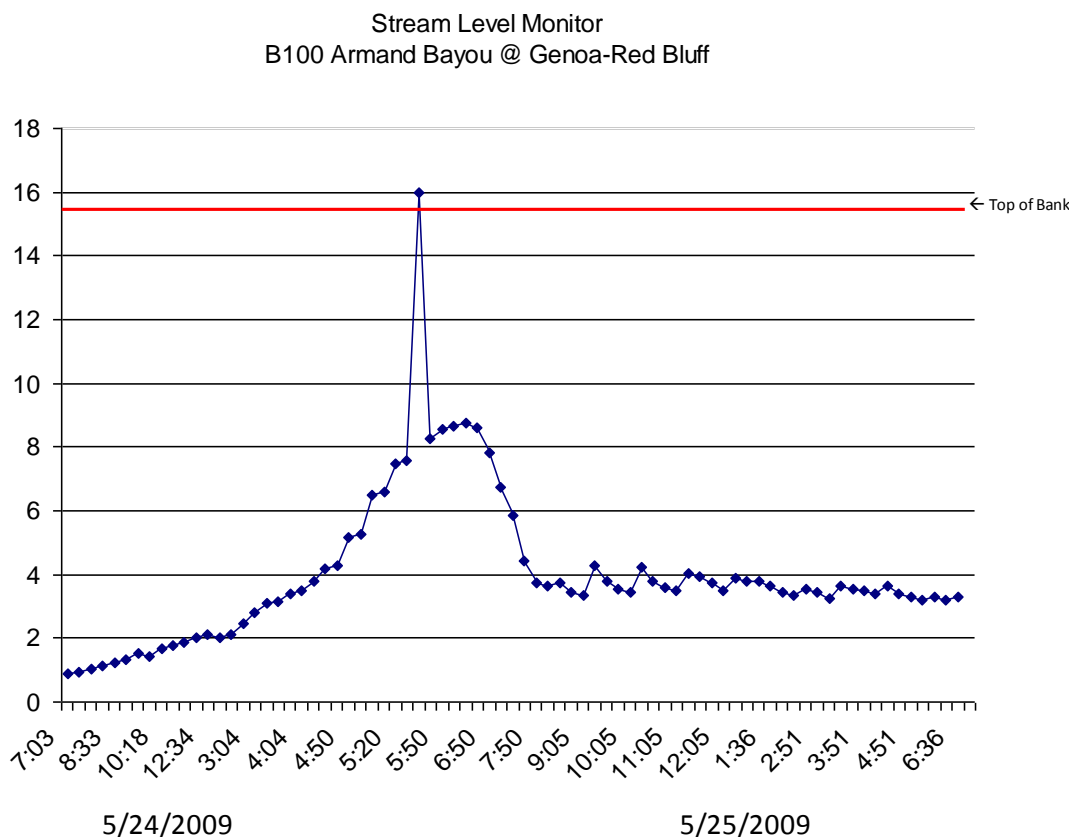
Figure 4. Aerial view of site 3 (Space Center Blvd @ Armand Bayou)



## **BASIC RUAA RESULTS**

### *Site Conditions*

All three sites were visited on all occasions and all required data were recorded. Completed scanned datasheets are included as Appendix 2. The flow on the first day of sampling (5/25/09) was significantly higher than the observed flow on the later two sampling events (7/4/09 and 7/25/09). This was due to the fact that a significant rainfall occurred on the day (5/24/09) previous to the first survey (Figure 5). Thus the average flow (cfs) that is being presented in this report is believed to be higher than the average base flow for Armand Bayou above tidal watershed (segment 1113A). However, flow conditions in the bayou on 5/25/09 did not resemble flood conditions; the stream was nominally wadeable, water in the stream was not turbid and conditions were deemed appropriate for assessment. The average air temperature and water temperatures were well within the requirements for sampling conditions as outlined in the RUAA procedures manual. Average stream depth and stream width are also reported in Table 2.



**Figure 5.** Stream Level Monitor data from the Harris County Office of Homeland Security & Emergency Management (OHSEM) website for the 24hours prior to Field Surveys conducted on 5/24/2009.

**Table 2.** Field data collected on Armand Bayou above tidal (TCEQ Segment 1113A) on 5/25/09, 7/4/09 and 7/25/09 for Basic Recreational Use Attainability Analysis surveys. Flow data for 7/4/09 has removed due to equipment malfunction.

Date	Site #	Site Description	Stream Flow (cfs)	Air Temp. (°C)	Water Temp. (°C)	Average Depth (m)	Average Width (m)	
5/25/2009	1	Genoa Red Bluff @ Armand Bayou	36.731	31.6	36.9	1.39	5.64	
	2	Fairmont Parkway @ Armand Bayou	26.657	32.3	26.9	0.66	3.69	
	3	Space Center Blvd @ Armand Bayou	2.394	30.4	26.6	0.53	5.33	
7/4/2009	1	Genoa Red Bluff @ Armand Bayou	-----		32	30	1.095	7.01
	2	Fairmont Parkway @ Armand Bayou	-----		37.5	30	0.31	3.51
	3	Space Center Blvd @ Armand Bayou	-----		36	31	1.325	2.29
7/25/2009	1	Genoa Red Bluff @ Armand Bayou	8.2467	33	28.5	0.8866	6.157	
	2	Fairmont Parkway @ Armand Bayou	5.4036	31	28	0.3837	4.176	
	3	Space Center Blvd @ Armand Bayou	2.3952	31	29	0.411	3.871	

A photographic record was taken at each site during each site survey. Photographs include an upstream view, left and right bank views, downstream views, and any evidence of

observed uses or indications or human use, hydrologic modifications, etc. Photographs are accompanied by the photographic record that depicts the site, date, location, view description, and view direction of each photograph (Appendix 3).

A summary of weather conditions during field survey days and for the past month is included in Appendix 4. The weather data includes, air temperature, dew point, humidity, wind speed, wind gusts, pressure, and precipitation.

### *Observed Uses*

Primary contact recreation was not observed during any of the three (3) Basic RUAA surveys that were completed. Secondary contact recreation in the form of fishing was observed on one occasion at site #1 at Armand Bayou @ Genoa Red-Bluff Rd on 5/25/2009 (Table 3). Other non-contact recreation such as walking, jogging, bicycling, standing, and sitting were observed over the entire spatial reach of the study.

**Table 3.** Recreational use observed on Armand Bayou above tidal (TCEQ Segment 1113A) during Basic Recreational Use Attainability Analysis surveys.

<b>Date</b>	<b>Site #</b>	<b>Activities Observed</b>
<b>5/25/2009</b>	<b>1</b>	<b>Walking, Standing, Sitting</b>
<b>5/25/2009</b>	<b>2</b>	<b>Fishing, Standing, Sitting</b>
<b>5/25/2009</b>	<b>3</b>	<b>Walking, Standing, Bicycling</b>
<b>7/4/2009</b>	<b>1</b>	<b>No recreation observed</b>
<b>7/4/2009</b>	<b>2</b>	<b>Walking, Bicycling, Jogging/Running</b>
<b>7/4/2009</b>	<b>3</b>	<b>No recreation observed</b>
<b>7/25/2009</b>	<b>1</b>	<b>No recreation observed</b>
<b>7/25/2009</b>	<b>2</b>	<b>No recreation observed</b>
<b>7/25/2009</b>	<b>3</b>	<b>No recreation observed</b>

## **SUMMARY AND RECOMMENDATIONS**

Based on our limited spatial and temporal surveys we were not able to detect any primary contact (e.g. swimming) recreation activities. We therefore recommend that a more in-depth Comprehensive RUAA be conducted on Armand Bayou above Tidal (segment 1113A). However, we did observe water related activities including fishing. In addition, site access is sufficient to permit primary contact recreation. Other important observations that may increase the probability of primary contact recreation occurring in this segment include documented human uses in the non-tidal and/or downstream tidal segment downstream of 1113A. These are discussed below.

1) A Texas Paddling trail is located in the tidal segment of Armand Bayou. It is unknown what proportion of users may venture into the non-tidal segment. There are no real barriers that prevent this movement. During our final field survey evidence of paddling (a paddle found on the bank and documented in the photographic record) was observed at Site 2.

2) Related to item (1) historically, kayaking, wading and fishing have been observed by various people, including the principal investigator at a county park located at the intersection of the Bay Area Boulevard and Armand Bayou Tidal segment. The kayaking activity occurs almost year round.

3) Organized wildlife boat tours are conducted by the Armand Bayou Nature Center and extend up to the upper portions of the tidal segment.

- 4) Marsh planting related to marsh restoration activities are conducted at the Armand Bayou Center in the downstream tidal segment.
- 5) Farther down in Clear Lake numerous water-related recreational activities are common and include jet skis, boating and fishing.
- 6) There is new evidence obtained from stakeholders during a public meeting regarding a rope swing on the non-tidal segment that has not been investigated. This would suggest possible use of the water body for contact recreation. The rope swing will be investigated and updated in the Comprehensive RUAA report.
- 7) The principal investigator has taken UHCL college students for Biology of Fishes field trips to the Armand Bayou at Fairmont Parkway site approximately every 1-2 years. During these trips it is not uncommon for students to periodically become immersed in the stream while picking up specimens, while wading or accidentally during falls.
- 8) One stakeholder indicated that more use of the bayou occurs downstream in the tidal portions and during the cooler weather months and by extension the non-tidal portion may also show a similar pattern. However, the comment focused primarily on kayaking and canoeing activity.

It is important to note that the methodology used during this RUAA is subject to all of the statistical and sampling bias found in any survey. For example, the ability to detect any person or activity including primary contact recreation is a function of many variables including the

magnitude of use in terms of number of individuals and the probability of observing a single person conducting primary contact recreation. This concept is discussed in detail as it relates to detecting rare species of animals and plants (Peterson and Bayley 2004). Briefly, the observability ( $q$ ) is the probability of observing a single individual conducting primary contact recreation in a given area. The qualification, “in a given area” means that as conditions affecting observability change in space or time, observability will change. Therefore observability ( $q$ ) can be treated as a random variable whose value is conditional on sampling conditions, as well as on the protocol used for observation or capture. Detectability ( $d$ ) is a related term that refers to the probability of detecting one or more individuals conducting similar behavior in a given area. Therefore if there are  $N$  individuals conducting the same activity with equal observability,  $q$ , and detectability is:

$$d = 1 - (1 - q)^N$$

Consequently detectability is very sensitive to both abundance and observability of individuals (Figure 6). A related issue is the desired detection limit, that is, what magnitude of primary contact use are we interested in detecting. This is directly related to the size (number of individuals) participating in the activity, the number of sampling events that are conducted and the desired power or ability to detect a real difference (primary contact use versus non-use) when it is in fact true (Figure 7)(Hintze 1996). Other sources of error are similar to those encountered by fisheries creel surveys and can include not detecting all potential access or activity sites and subsequent under reporting of activity (Pollock et al. 1994). This represents site and time selection sources of error that is not directly related to the previous discussion on statistical issues.



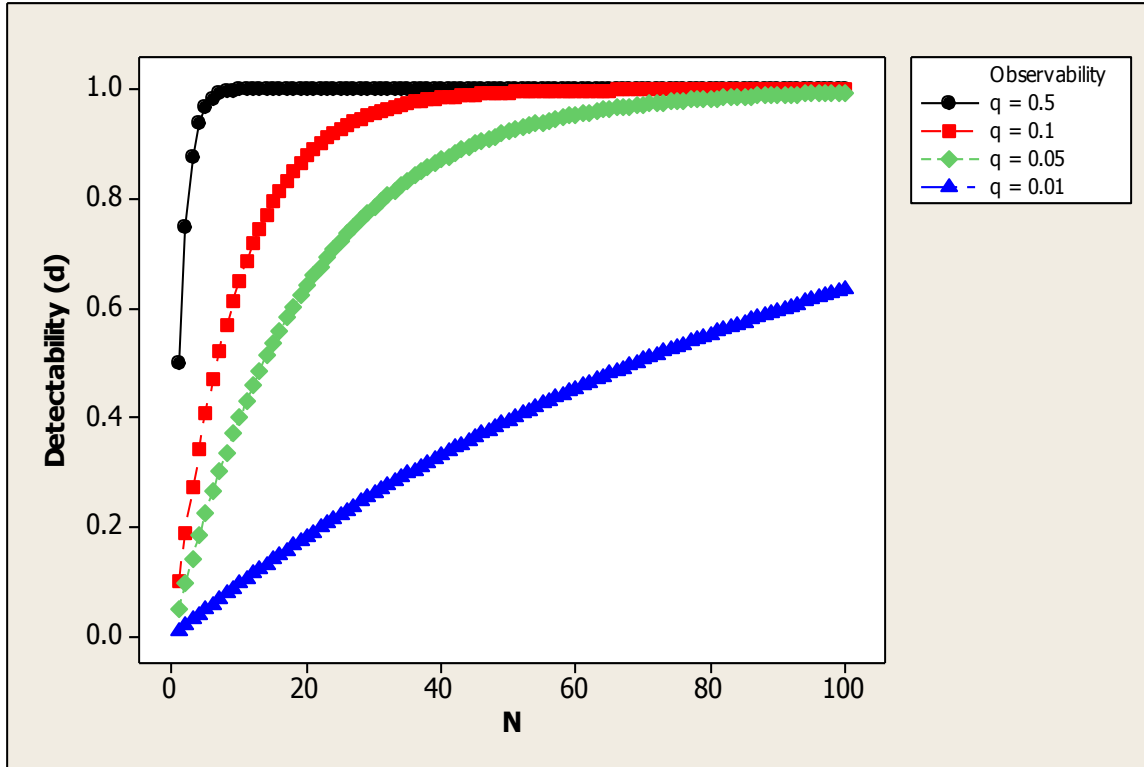
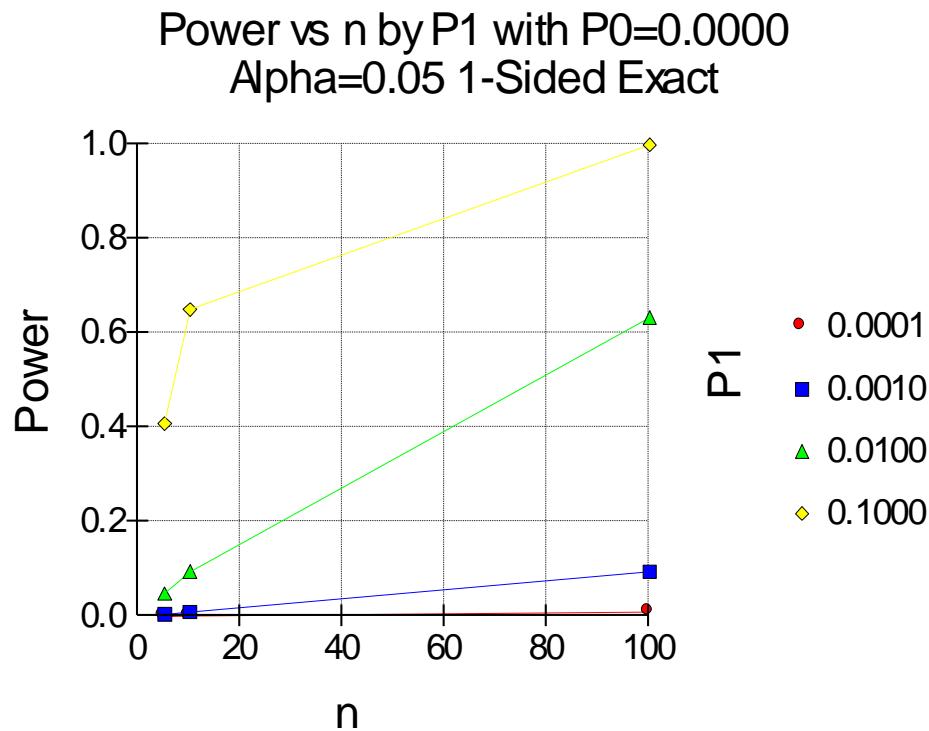


Figure 6. Detectability (d) of an observed activity versus number of individuals' present (N) conducting activity for selected values of observability (q).



**Figure 7.** Statistical power (ability to detect real difference, when null hypothesis is false) varies with sample size ( $n$ ) and magnitude of desired difference we wish to detect. Assuming no one ( $P_0$ ) uses the stream versus some proportion ( $P_1$ ).

Due to these factors it is important that future recreational use attainability analyses carefully qualify results that may yield apparent “non-primary use” due to lack of observed activity, since these observations may only be statistical artifacts caused by low observability and numbers, or low sample size (number of survey events both spatially and temporally). These problems underscore the need for complementary onsite questionnaires and background reviews to insure that streams with low recreational use levels are not incorrectly classified as having no recreational use. Finally, although the RUAA methods attempt to measure and characterize stream conditions that may affect recreational use, non-linear responses to varying environmental conditions such as streamflow can affect perceived recreational quality in an unpredictable manner and this will often differ between streams (Brown et al. 1991). These

non-linear responses complicate the ability to identify factors that may limit contact recreation.

This is important because if surveys are conducted during periods of lower perceived recreational quality, this may result in lower actual recreational use.

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